Ultra-Long Duration Balloon
Control Center
Operations Concept Document

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Signature Page

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Change Information Page

Version	Date	Description	Affected Pages
1.0	08/03/98	Original.	all
1.1	08/26/98	Updated following internal branch review.	all
1.2	09/09/98	Updated to reflect changes in requirements.	all

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1.0 Introduction

Recent advances in composite super-pressure balloon materials have greatly enhanced the prospects for very long duration balloon flights on Earth as well as possible use for planetary exploration. NASA is embarking on the development of technologies to support extended balloon missions lasting up to 100 days (~5 circumnavigations of the globe) above 99.9% of Earth's atmosphere.

The ULDB objective is to develop a low cost, integrated, advanced, long duration balloon system which is technically feasible and within program cost constraints while maintaining the existing balloon program. The ULDB program is significantly different from the current balloon program in that the expected science return is significantly greater than current balloon missions. In other words, it is more than simply extending current experiments over a longer time period. This program also expects to use technologies currently available in the spacecraft missions and commercial arenas to improve performance while containing costs.

The purpose of the ULDB Control Center software effort is to provide ULDB scientists, engineers, and mission operators with an integrated tool set with which they can monitor the status of and issue commands to ULDB instruments. The systems will support integration, pre-launch checkout, launch, float, and terminate operations.

1.1 Purpose

This document describes the ULDB Control Center operations concept. It is intended to describe the behavior of the control center systems in terms of operational methods and scenarios.

1.2 Applicable Documents

1.2.1 Project Documentation

The following ULDB project documentation is applicable and/or related to this document.

ULDB Design-To Requirements Document, revision 1.2, December 3, 1997,
http://www.wff.nasa.gov/~uldb/designreqmts.pdf

1.2.2 Subsystem Documentation

The following ULDB Control Center specific documentation is applicable and/or related to this document. These documents are available via the ULDB Control Center page:
http://www.wff.nasa.gov/~code584/ULDBControlCenter/index.html.

ULDB Control Center Product Plan
ULDB Control Center Software Development Management Plan
ULDB Control Center Requirements and Functional Specifications

1.3 System Overview

The ULDB Control Center will include several systems that are designed to coordinate communication

be combined into one or more physical subsystems. The functional areas are General System, Telemetry Acquisition, Command, Data Management, Real Time Monitor and Control, and Data Analysis.

The OCC and the ROCC will use and support the Space Network (SN), INMARSAT, Iridium, and ARGOS networks to obtain forward and return link data communications. In addition, the ROCC will use and support Line-of-Sight (LOS) networks. Both systems will provide tools used to manage the planned operations of the ULDB missions. The systems will provide the capability to receive, process, and monitor telemetry data from the balloon-craft. They will provide the capability to validate, build, up-link, and verify real time commands for the ULDB balloon-craft and instruments. They will provide up-link and verify memory loads for the balloon-craft and instruments and verify execution of stored commands for the balloon-craft and instruments during a real time contact. The systems will provide a Project Data Base (PDB) containing information necessary to support mission operations. Telemetry, command, and constraint definitions will be maintained within a PDB for each mission. The system will include Operations and Engineering interfaces that provide users with the ability to monitor and control the balloon-craft instruments. The systems will provide analysis capabilities to maintain the health and safety of the ULDB balloon-craft and instruments. The analysis function will provide ULDB operations personnel with the tools necessary to perform balloon-craft systems management, performance analysis, trend analysis, fault detection, isolation, and recovery, and configuration management.

A computer-based software system shall be provided to monitor balloon-craft and science instruments and provide limited control of those instruments. This system shall be referred to as the Remote Monitor and Control System (RMCS).

A complete description of the functions of each of the ULDB Control Center systems is included in the ULDB Control Center Requirements and Functional Specifications.

2.0 Operational Environment

This section describes the operating environment in which the control center systems are expected to be used. Both the OCC and ROCC will be operated in an environmentally controlled location with redundant power supply. All associated systems will be desktop stations and make use of existing network infrastructures.

2.1 OCC

The OCC will be placed in the ULDB Operations Control Center. It will consist of one real time server, one analysis server, and one fully configured backup server that is capable of providing all of the functionality of either the real time or analysis server. An external interface server will act as the interface to the PIs for distribution of the science data, for transfer of engineering data to the RMCS, and as the Web server.

2.2 ROCC

The ROCC will be located at the launch site. It will consist of one real time server, one analysis server, and one fully configured backup server that is capable of providing all of the functionality of either the real time or analysis server. An external interface server will act as the interface to local PIs for distribution of the science data.

3.1 Pre-Mission Operations

The OCC and ROCC will make use of Project Data Bases (PDB) to specify mission specific telemetry, command, and constraint definitions. These definitions will be used by the ULDB Control Center systems during real time operations to control the format and contents of data distributed to and from the various elements of OCC and ROCC systems. Manipulation of the PDB will be part of, but not necessarily limited to, the pre-mission operations. The OCC/ROCC will include software tools with which additions, deletions, and modifications of the PDB can be accomplished.

In support of pre-mission operations, operators will create and manipulate PDB related files. Familiarity with Windows-type graphical and textual user interfaces, including menu-driven and mouse-driven applications, is required.

3.2 Real-Time Operations

The OCC and ROCC will receive, process, and monitor telemetry data from the balloon-craft. All packets, regardless of application identifier, will be stored by the data storage function. Balloon-craft housekeeping data will be presented as a collection of graphical and text displays for monitoring by ULDB Control Center personnel. Packets whose application identifiers indicate them to be science data or science housekeeping data will be forwarded without further processing to the instrument PI(s).

Furthermore, the ULDB Control Center systems will, based on commands executed by ULDB Control Center operators, validate, build, up-link, and verify real time commands for the ULDB balloon-craft and instruments.

During real-time operations, operators will initiate commands for up-link to the balloon-craft, and monitor and manipulate Windows-type displays. Familiarity with Windows-type graphical and textual user interfaces, including menu-driven and mouse-driven applications, is required.

3.3 Analysis Operations

The OCC and ROCC will provide analysis capabilities to maintain the health and safety of the ULDB balloon-craft and instruments. ULDB operations personnel will have the tools necessary to perform balloon-craft systems management, performance analysis, trend analysis, fault detection, isolation, and recovery, and configuration management. All balloon-craft housekeeping telemetry data, statistical data generated by the OCC, and all operator-generated stored dataset files will be available as input to the analysis process.

In performing telemetry data analysis of balloon-craft housekeeping data, operators will use an integrated toolset to monitor and manipulate Windows-type displays. Familiarity with Windows-type graphical and textual user interfaces, including menu-driven and mouse-driven applications, is required.

4.0 Operational Description

4.1 OCC/ROCC Functions

launch, early float, early float contingency terminate operations, flight, flight contingency terminate, and terminate operations. The systems will provide an external interface to various project supporting elements.

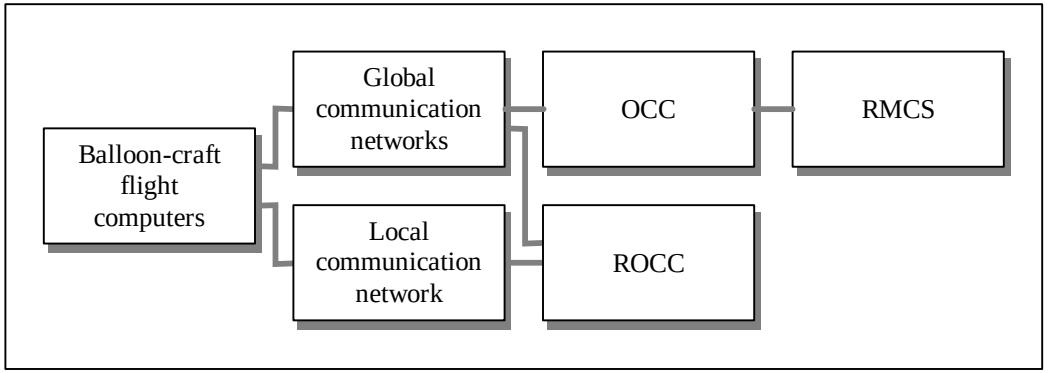

Figure 4.1-1

4.1.2 Telemetry Acquisition

The systems will accept and process telemetry data; the data will be converted from raw counts to engineering units (EUs). Both raw and EU converted values will be accessible to the users. The system will perform delta value checking any processed telemetry. A delta value is the maximum change expected between successive samples of a parameter. Range checking will be performed on raw or EU-converted values whenever range limits have been defined in the PDB. A limit condition change notification will be generated each time a parameter crosses a limit threshold value (when it exceeds a limit or when it comes back within a limit). A change in limit state may cause a notification to be output for display and/or logging. Notification is also provided during the time a parameter remains out of limits. The systems will display balloon-craft housekeeping and other parameters required to support ULDB operations. Downlinked real time and balloon-craft recorder playback housekeeping and instrument engineering telemetry will be stored. Stored real time and balloon-craft recorder history telemetry may be processed by specifying the data type and start and (optionally) stop time. Replay operations simulate real time telemetry processing, including limit and delta limit checking, and will likewise permit the generation of derived parameters. Raw science data and raw science housekeeping data will be forwarded to PIs in near-real time.

4.1.3 Command

The ULDB Control Center systems will have the capability to transmit commands to the ULDB balloon-craft and instruments using multiple interfaces. The OCC and ROCC systems will validate, build, up-link, and verify real time commands for the ULDB balloon-craft and instruments. The OCC and ROCC will provide tools used to manage the routine, planned operations of the ULDB missions. Planned operations are managed by means of scripts containing stored commands and/or data. The OCC and ROCC will control the up-link of critical commands by requiring a second positive response from the operator. If a command procedure is being executed, authorization is required for each critical command to be up-linked.

4.1.5 Real Time Monitor and Control

Balloon-craft housekeeping data will be presented as a collection of graphical and text displays for monitoring by ULDB Control Center personnel. The ULDB Control Center systems will provide users the ability to manage their desktop environment. Software tools will provide the capability to define a real time display. The OCC/ROCC will allow users to request the privilege to send commands to the instruments on the balloon-craft. This privilege is extended only to authenticated users, and ensures that only one person has command authority at any one time.

4.1.6 Data Analysis

The OCC and ROCC will provide analysis capabilities to maintain the health and safety of the ULDB balloon-craft and instruments. ULDB operations personnel will have the tools necessary to perform balloon-craft systems management, performance analysis, trend analysis, fault detection, isolation, and recovery, and configuration management. All balloon-craft housekeeping telemetry data, statistical data generated by the OCC, and all operator-generated stored dataset files will be available as input to the analysis process. The OCC will store all valid databases and make these available for analysis of historical data.

5.0 Requirements Traceability

The General System functions described in Section 4.1.1 satisfy the requirements OCC-GEN-XXXXX[1] and ROCC-GEN-XXXXX defined in the ULDB Requirements and Functional Specifications.

The Telemetry Acquisition functions described in Section 4.1.2 satisfy the requirements OCC-TLM-XXXXX, ROCC-TLM-XXXXX, and RMCS-TLM-XXXX defined in the ULDB Requirements and Functional Specifications.

The Command functions described in Section 4.1.3 satisfy the requirements OCC-CMD-XXXXX, ROCC-CMD-XXXXX, and RMCS-CMD-XXXX defined in the ULDB Requirements and Functional Specifications.

The Data Management functions described in Section 4.1.4 satisfy the requirements OCC-DAT-XXXXX and ROCC-DAT-XXXXX defined in the ULDB Requirements and Functional Specifications.

The Real Time Monitor and Control functions described in Section 4.1.5 satisfy the requirements OCC-RMC-XXXXX, ROCC-RMC-XXXXX, and RMCS-XXX-XXXX defined in the ULDB Requirements and Functional Specifications.

The Data Analysis functions described in Section 4.1.6 satisfy the requirements OCC-ANL-XXXXX and ROCC-ANL-XXXXX defined in the ULDB Requirements and Functional Specifications.

6.0 References

The following documents are considered reference materials with have relevancy to this document.